



ZERO LEARNING ACADEMY
MOVING TOWARDS AI BASED LEARNING

Application of Bioluminescence in Food



BY

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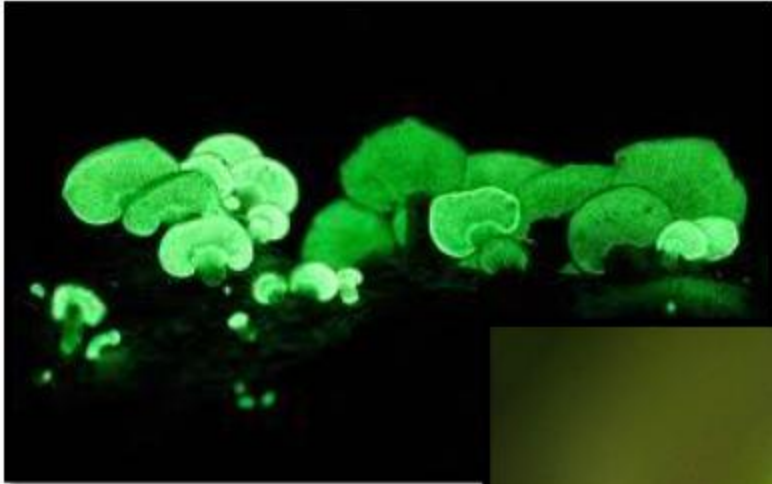
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What is Bioluminescence ?

- **Bioluminescence** is the production and emission of light by a living organism.
- It is a form of chemiluminescence.
- **Bioluminescence** occurs widely in marine vertebrates and invertebrates, as well as in some fungi, microorganisms including some **bioluminescent** bacteria, and terrestrial arthropods such as fireflies.

Terrestrial Bioluminescence

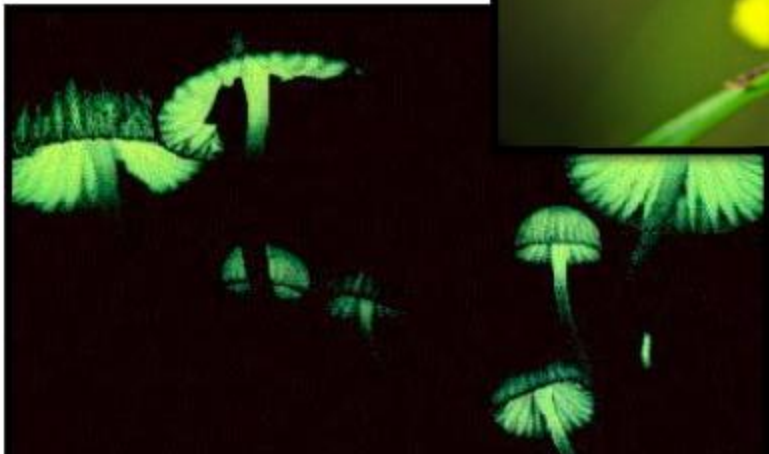


 Fungi, Algae


 Mushrooms



 Firefly



 Glow Worms

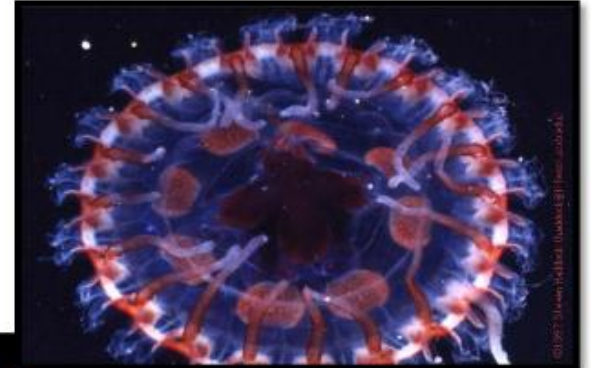
 Earthworms

Aquatic Bioluminescence

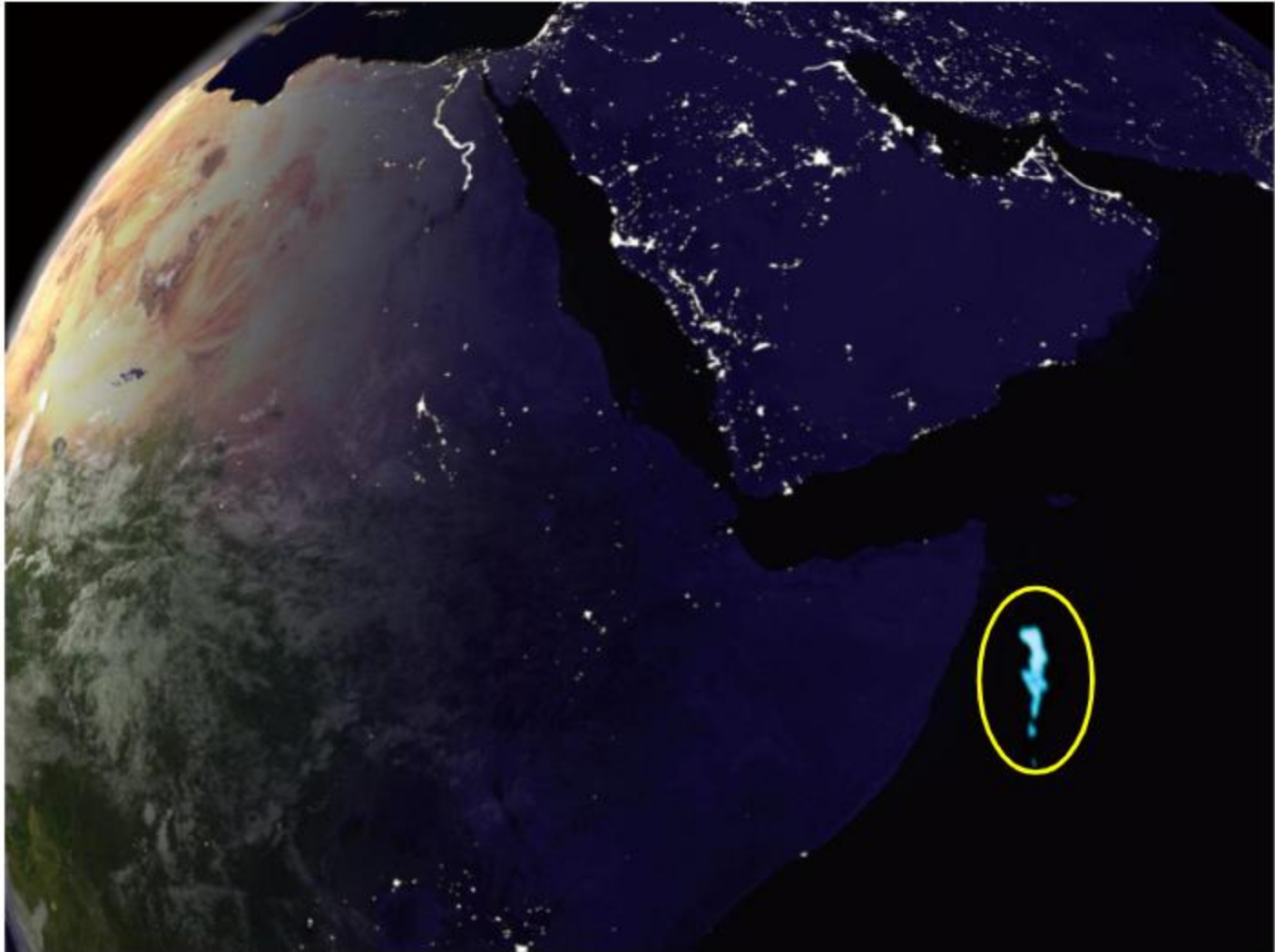


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- 80- 85% of oceanic world is bioluminescent
- Jellyfish, coral.
- Dinoflagellates



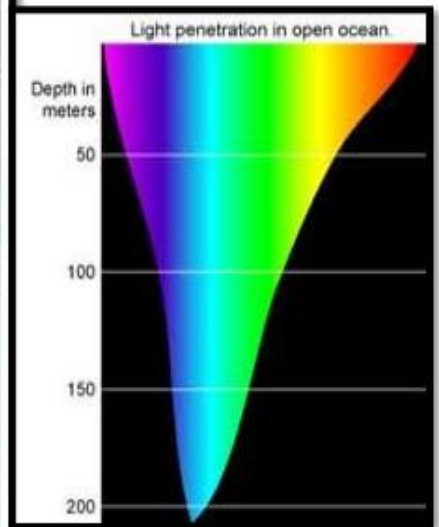
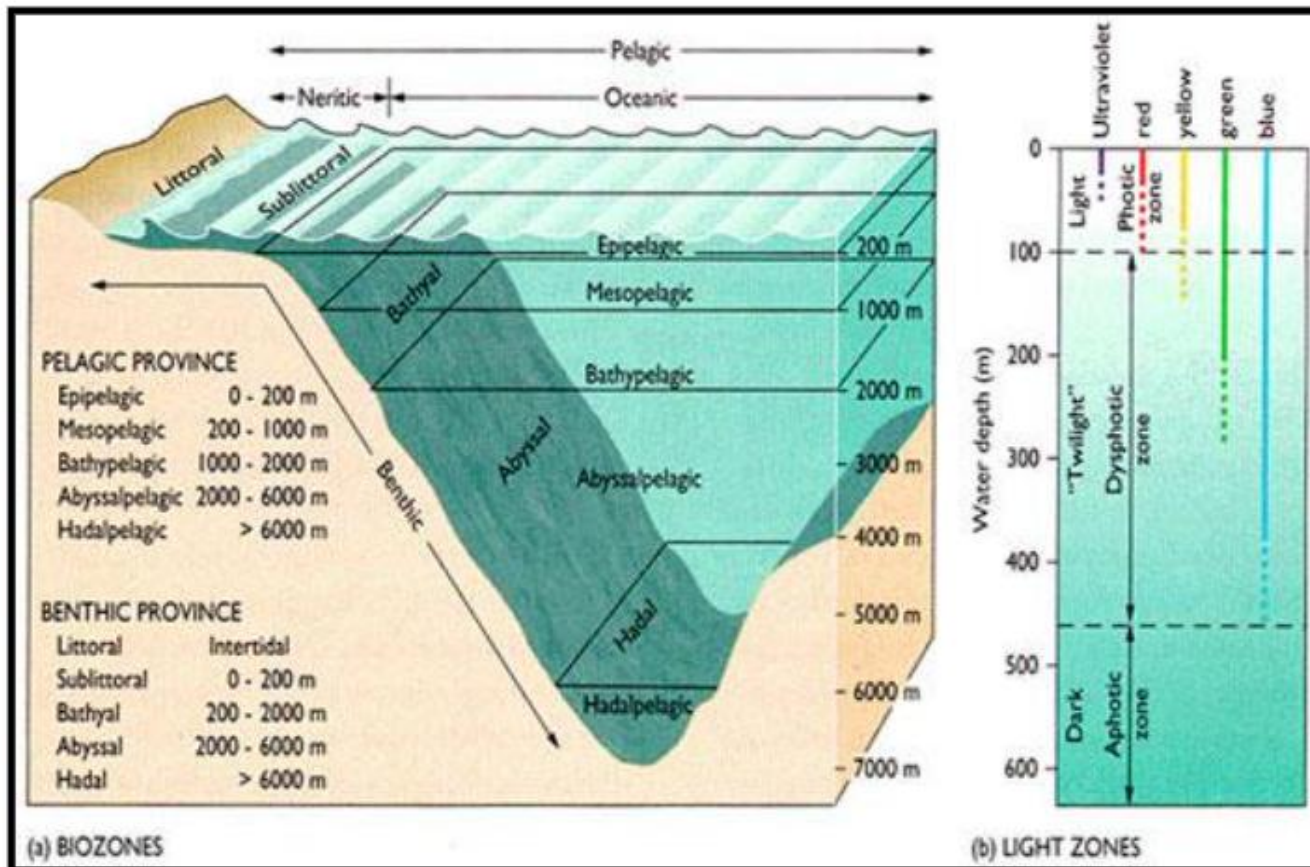
Bioluminescence Near Cape Horn



Bioluminescence.. In Sea



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Major reason why most bioluminescent organisms emit blue or green color



Why does it occur !!

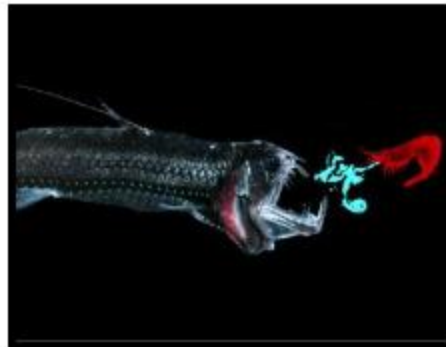
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Invitation to a meal



Clever disguise



Puzzling predators



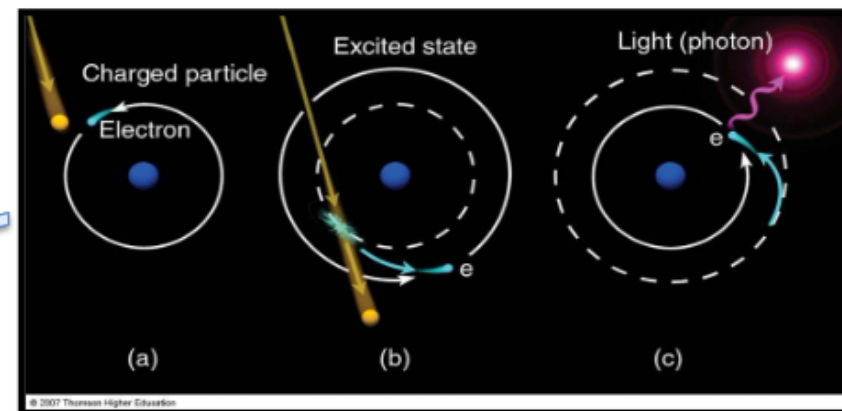
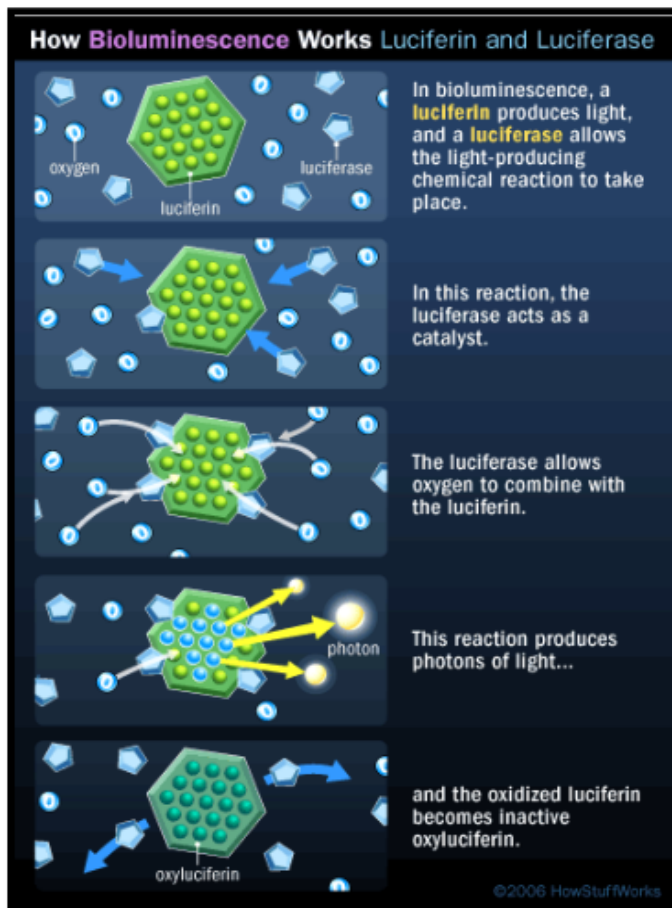
Burglar Alarms



Mating games



How it Happens?



luciferin

luciferase



Bioluminescence Vs. Fluorescence and Incandescence

Incandescence

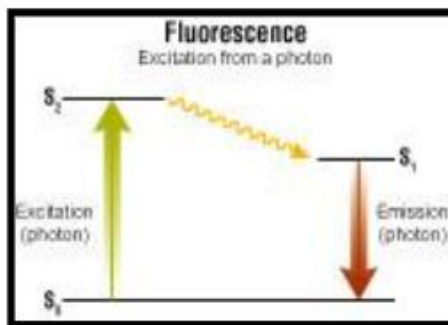
Heat → Light



Lowest efficiency

Fluorescence

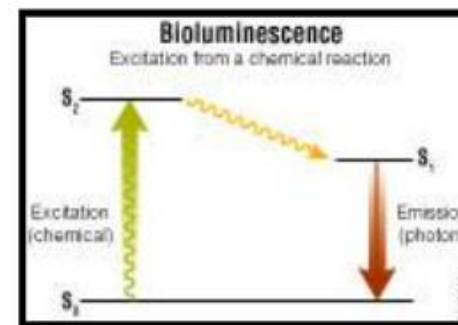
Light → Light



Moderate Efficiency

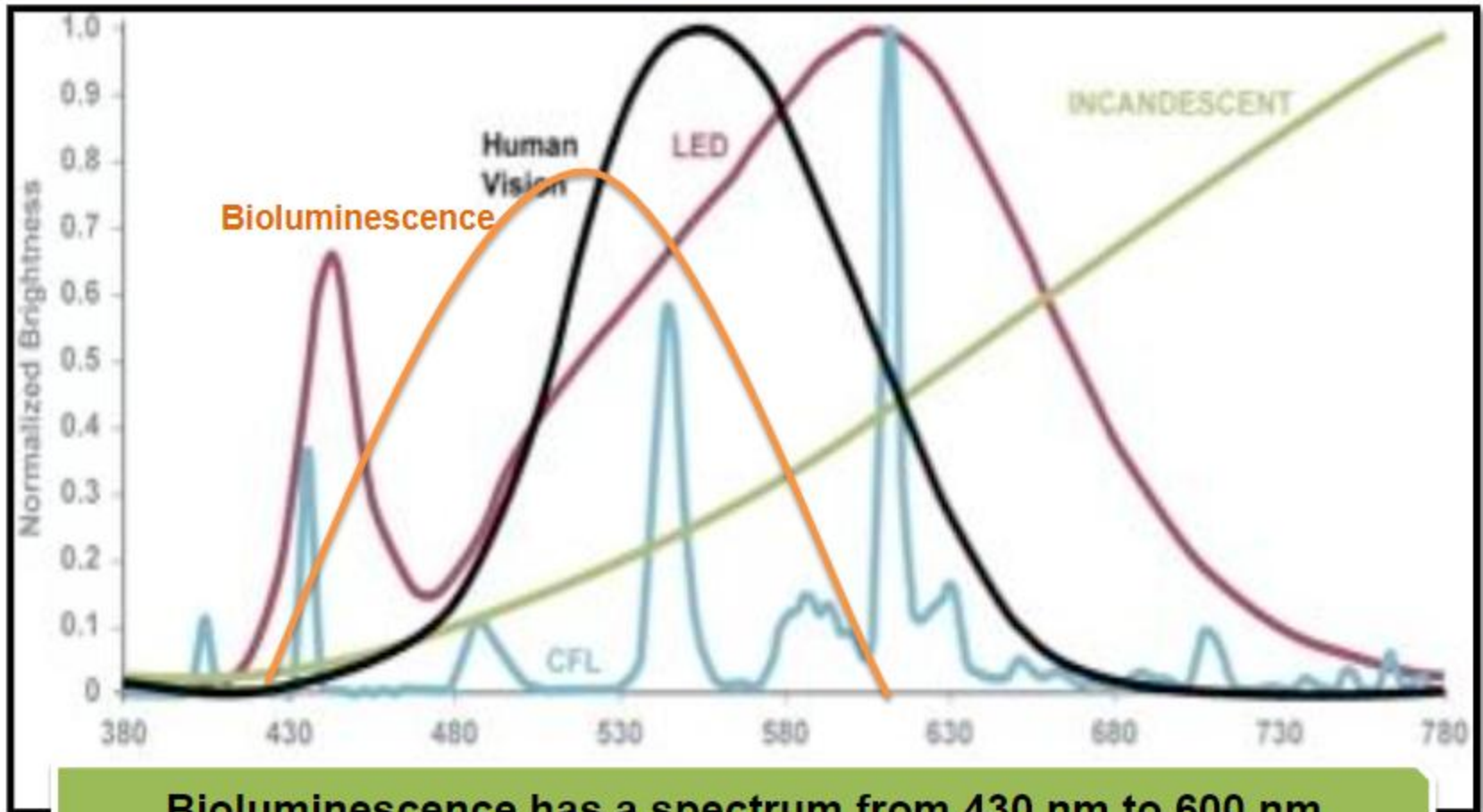
Bioluminescence

Chemical → Light



Highest Efficiency

Bioluminescence Vs. Fluorescence and Incandescence

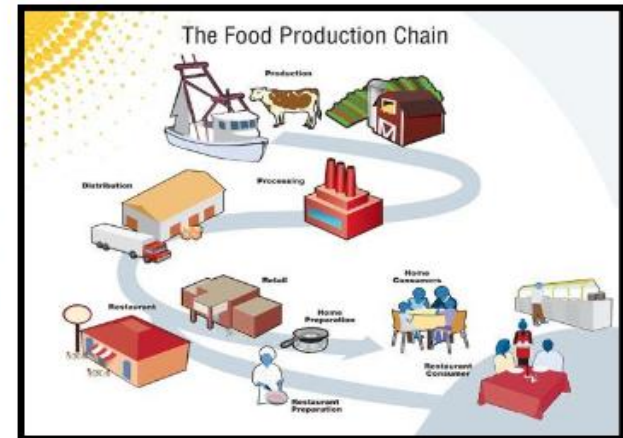


Applications of bioluminescence in food

Food Industry

Food travels longer distances today

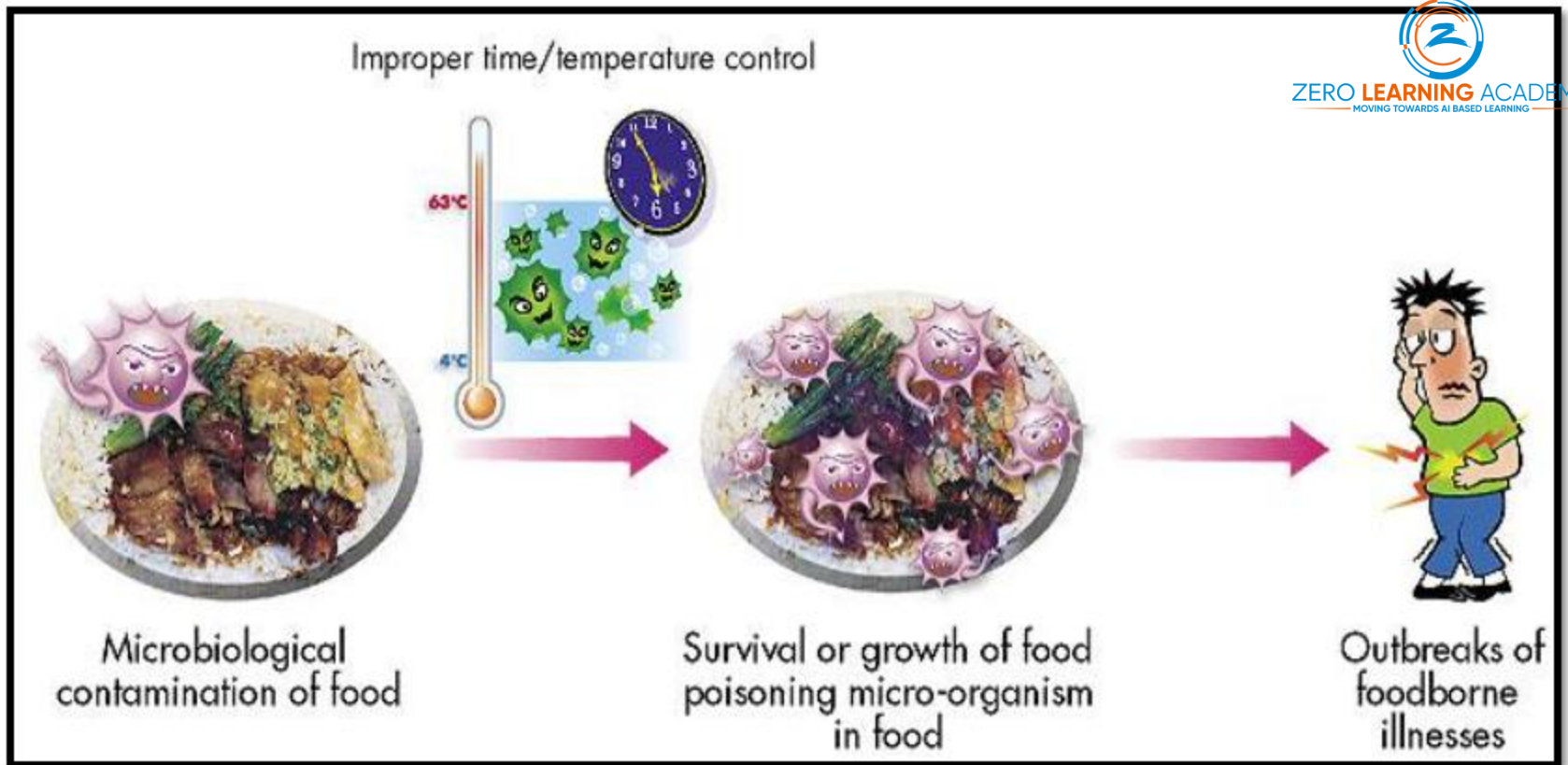
A study by the Leopold Center for Sustainable Agriculture in The USA showed a 22% increase in the average distance travelled by food products (arriving in Chicago) by truck in the past 2 decades.



Current food regulations

- Food development and Authority
- HACCP (Hazard Analysis and Critical Control Points)
- Principle 4 – Establish monitoring procedures
- When and which food should undergo microbiological test



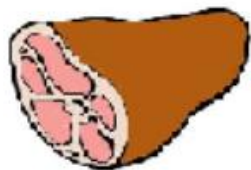


According to The US National Library of Medicine, in the United States alone about **48 million** people get sick from consuming contaminated food **each year**.

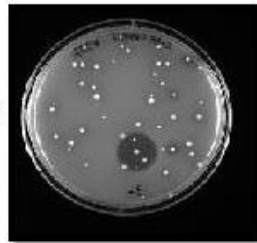
Applications in food microbiology

Existing method for detection of food contamination

Total Viable Count (Standard Plate Count/Aerobic Plate Count)



Sample from food item



Dilution planted in agar based media



Incubation period



Counting bacteria

Existing methods for detection of food contamination - Limitations



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- Expensive laboratory equipment.
- Long wait involved, anywhere between 24-48 hours. In cases of fermented foods (such as soy sauce) this period could extend up to 7 days. This increases the storage time before fresh food can reach the market, and may actually decrease the quality of the food during the waiting period.
- Tedious and labor intensive. The enumeration of colonies is performed using an illuminated colony counter. There is also a minimum requirement of 30 colonies (maximum to not exceed 300) for accurate results.
- Results unnecessarily elaborate in cases where results are required to only immediately confirm if food is fit for consumption.
- Requirement of specialized transportation.

Evolution of the concept of ATP bioluminescence in food industry

WHAT?

Adenosine-5'-Triphosphate (or ATP) is the most **important biological fuel** in living organisms, and the detection of ATP origination can be important to detect living microorganisms such as pathogens.

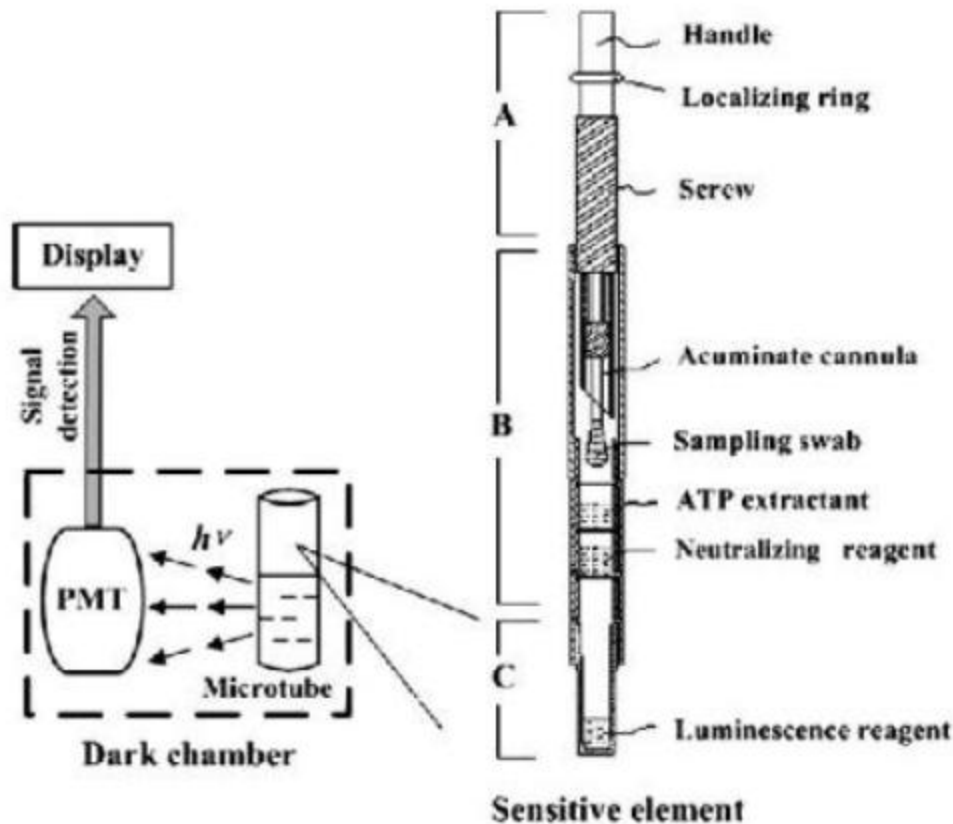
HOW?



WHY?

The visible glow of pathogen helps provide instant counting results.

Applications in the Food Industry



VALUE PROPOSITION

- Disposable
- Low cost
- Easy operation
- Fast response

Prototype of ATP bioluminescence based Biosensor for detection of bacteria

Opportunities in the Food Industry

- In a local butcher shops for detection of contaminated food substances such as meat.
- To quickly and easily detect if small individual samples (i.e. per bottle) of fluids, such as milk or water, have been contaminated/spoiled during packaging transportation.
- In remote areas such as Saharan desert and Alaska.
- Can be used by rescue workers during natural disasters such as earthquakes and tsunamis.
- Future Space missions (e.g. during a long mars mission)



Opportunities in industry



- BioLume : Bioluminescent bacteria added will be regulated as a 'food additive' by the FDA.
- Huge profits possible in the industry due to novelty factor.
- Tourism opportunities in a country like Singapore.